



# Is your house bolted down?

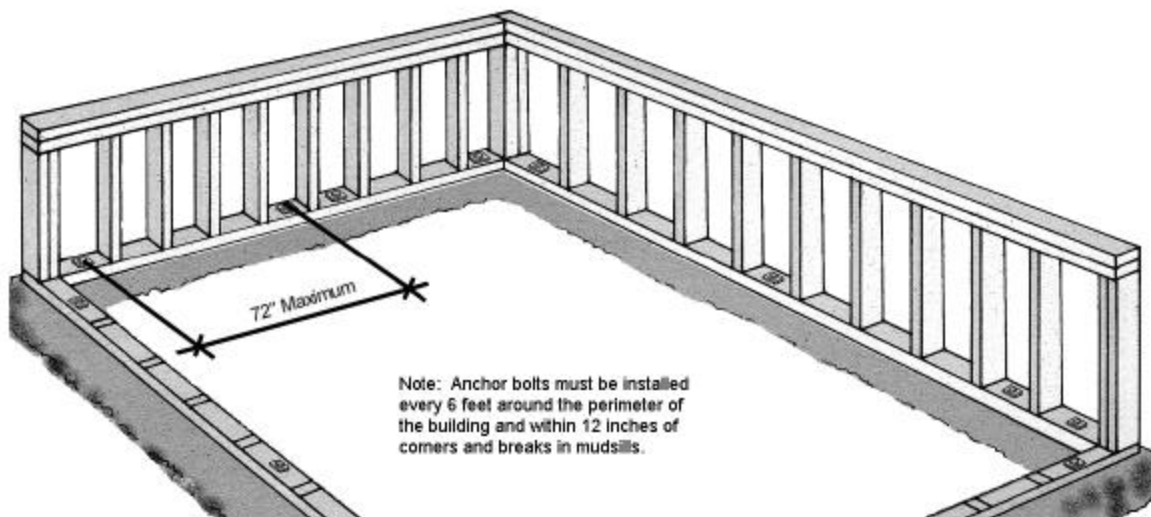
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**What To Look For:** The place to start is in the crawl space under your home. The wood 2 by 4 or 2 by 6 that rests directly on the foundation is called the "mudsill". The mudsill should be bolted at 6 foot intervals, and a bolt should be located within 12 inches of every joint, step and corner in the mud sill, but no closer than 4 inches from the end of the board. A minimum of 2 anchor bolts are required per board. If the mudsill is not bolted, or not bolted in this manner, the building is not properly attached to the foundation.

**Cripple Walls:** Check to make sure your cripple walls are braced with plywood to resist lateral movement. Even if your cripple walls have cross bracing, they are not strong enough for earthquakes unless you add plywood.

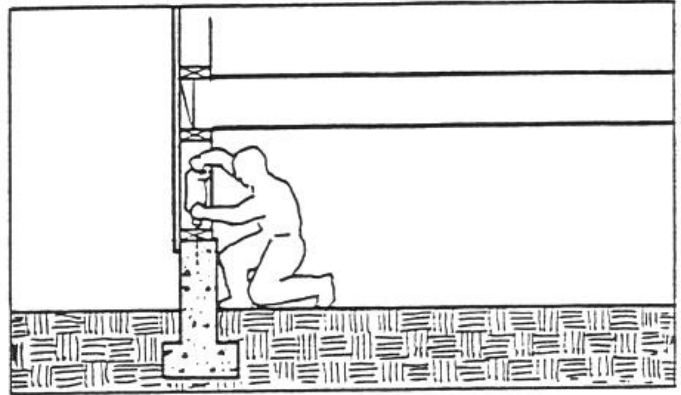
**Check For Faulty Materials:** The foundation is a common area of structural weakness, so check the foundation to assure it is in sound condition. Sometimes the concrete used in foundations is too porous and crumbly to provide adequate strength. If so, the building is subject to earthquake damage, even if it has been bolted down and the cripple walls have been reinforced with plywood. If the foundation is unsound, contact a licensed engineer or professional contractor for adequate repair materials and methods.

**Cost:** Anchor bolts cost as little as \$2.00 each so the perimeter of an average size home can be bolted down for a couple of hundred dollars plus labor. You can obtain a permit and do the work yourself. Utilize the details on the next few pages to help you in installing anchor bolts and plywood on cripple walls.

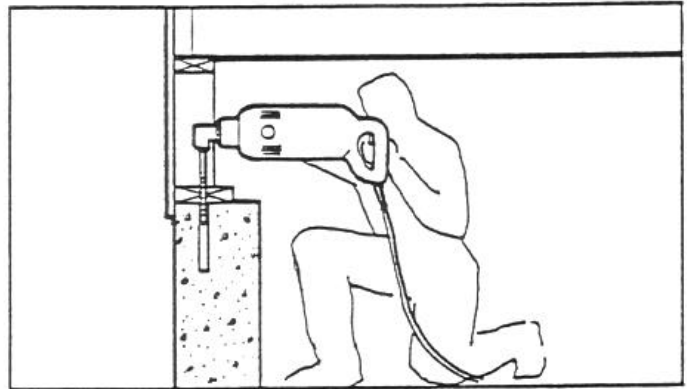


**TYPICAL FOUNDATION BOLT INSTALLATION**

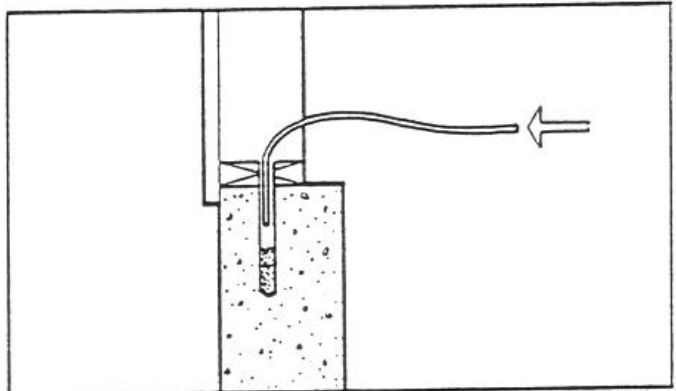
Follow the guidelines below for bolting a building to a concrete foundation. Make sure that the mudsill and concrete stem wall are in sound condition capable of receiving foundation bolts.



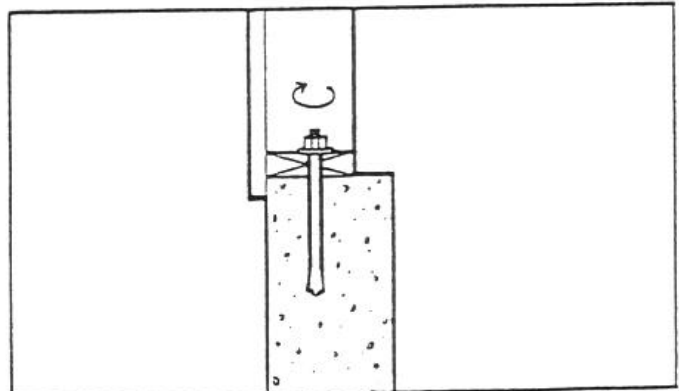
**Drill The Holes:** Drill holes through the mudsill into the concrete stem wall at least 9 inches using a rotary hammer equipped with a carbide tip concrete drill bit of the proper size.



**Clean The Holes:** After drilling the holes, remove all concrete dust from the holes. This can be accomplished by using a flexible tube to gently blow the concrete dust out of the holes. (This is especially important if you are using epoxy method bolting.)



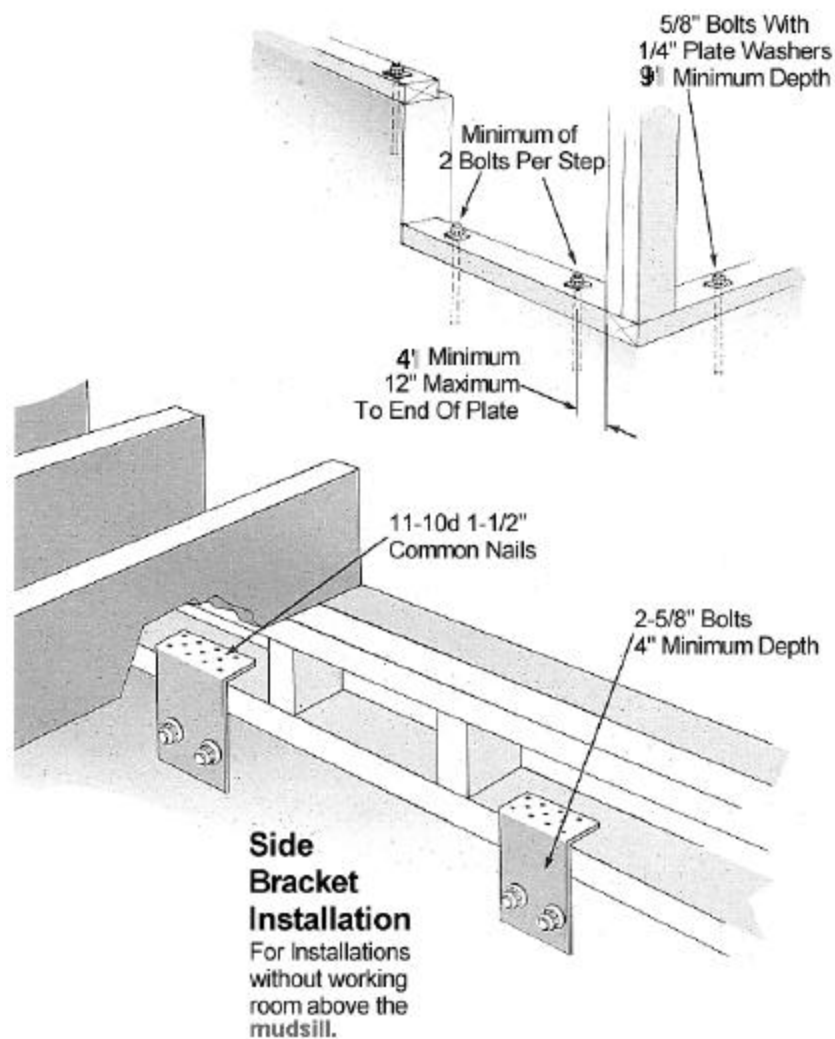
**Installing The Bolts:** Expansion bolts are designed to be hammered into place. This can be done without damaging the bolt's threads by turning the washer and nut past the end of the bolt and tapping on the end of the bolt shaft to hammer the assembly into place. Once the bolt is in place, tighten the nut down firmly.



**TYPICAL BOLT DOWN FOR STEP FOUNDATION AND SIDE BRACKET**

**Stepped Foundation:** If your house is built on a hill or even a slight grade, you may have some step like offsets in your foundation. On every step the mudsill must be bolted down.

**Side Brackets:** If working room is limited above the mudsill to drill down, you may secure the mudsill to the foundation with side brackets. This is a manufactured product which is "Listed" and approved for this application. Side brackets may only be used where the mudsill and foundation stem wall concrete are in sound condition capable of receiving nails and bolts. Follow the manufacturers installation instructions.



### REINFORCED CRIPPLE WALLS WITH PLYWOOD

**Bolts Are Not Enough:** Even though your house is bolted to its foundation the lateral forces of an earthquake can make the weakest part of your house (typically the cripple walls) buckle and collapse. Plywood sheets, normally  $\frac{1}{2}$  inch in thickness, should be nailed to the cripple walls on all sides of your house. These sheets create shear panels that give the house lateral strength. Old fashioned 2 by 4 or 2 by 6 cross braces and horizontal braces are not strong enough during a strong earthquake.

**How Much and Where:** For a single story house, you should add plywood to at least  $\frac{1}{3}$  of each wall length. For a 2 story house, you should reinforce at least  $\frac{1}{2}$  of each wall length. Distribute the plywood evenly along the cripple walls using sheets no shorter than 4 feet. Larger sheets, long enough to evenly cover the spaces between the cripple wall studs, should be used whenever possible.

**Blocking:** Blocking provides an even nailing surface for each plywood edge. Often the mudsill is embedded into the concrete foundation too deeply to allow nailing along its edge. If so, you will need to add pieces of 2 by 4 or 2 by 6 blocking on top of the mudsill to provide a nailing surface. To prevent dry rot or termite damage, use pressure treated wood for the blocking.

**Nailing:** Whether you use a nail gun or a hammer, nails are a critical part of effective bracing. Each sheet of plywood must be nailed every 4 inches around the edges and every 12 inches along all interior cripples and cross braces with 8d nails.

**Ventilation Holes:** Drill 3 inch ventilation holes in each sheet. These holes should be centered between each set of studs and 2-1/2 inches above the mudsill and 2-1/2 inches below the bottom of the plates. See illustration below.

